WRITTEN TESTIMONY OF

Boris X. Camiletti, Assistant Professor
Department of Crop Sciences
University of Illinois Urbana-Champaign

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Hearing on *"Innovations in Agrichemicals: AI's Hidden Formula Driving Efficiency"*

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Chairman Franklin, Ranking Member Amo, and Members of the Subcommittee, thank you for the opportunity to submit testimony for this hearing titled, *Innovations in Agrichemicals: AI's Hidden Formula Driving Efficiency*. I am delighted to participate in this important discussion on innovations in the agrichemical industry as they relate to new technologies, including artificial intelligence (AI). I also thank the Subcommittee for its ongoing support of scientific research and its commitment to training the next generation of scientists, engineers, and educators.

My name is Boris Camiletti, and I am an Assistant Professor in the Department of Crop Sciences and an affiliated member of the Center for Digital Agriculture (CDA) at the University of Illinois Urbana-Champaign (UIUC). I lead a research program focused on plant disease management in agricultural systems, with a strong emphasis on optimizing the use of fungicides. Originally from Argentina, I came to the United States in 2016 as a Fulbright Scholar to advance sustainable strategies for crop protection. My research group takes a multidisciplinary approach that integrates plant pathology, remote sensing, and AI to develop data-driven solutions for disease detection and targeted agrochemical applications. Specifically, we use machine learning algorithms to analyze satellite imagery, enabling site-specific fungicide treatments that reduce environmental impact and lower input costs for farmers. This AI-driven framework enhances decision-making and improves on-farm product use efficiency—reducing costs and improving outcomes for farmers—core themes of today's discussion.

The Need for Optimizing Fungicide Use to Control Red Crown Rot of Soybean

Soybean is a cornerstone of the U.S. agricultural economy, and the Midwest plays a central role in its production. However, soybean farmers across this region are now confronting a rapidly emerging threat: red crown rot (RCR). This disease was first identified in Midwestern production systems in 2018 in Pike County, Illinois, and has since spread across the state and into neighboring regions, including Kentucky, Indiana, and Missouri.

RCR affects leaves, lower stems, and roots, often causing premature plant death and resulting in irregular patches across fields. Infected plants may appear stunted, produce fewer pods, and generate lighter seeds—outcomes that translate into substantial yield losses, in some cases up to 50 percent. In response, some farmers are shifting to continuous corn cultivation in an effort to reduce risk and avoid severe yield losses. With more than 17 million acres of soybean production at risk in Illinois, Indiana, and Kentucky alone, RCR has become one of the most pressing challenges for the soybean industry, with implications that extend to national and global markets and rural livelihoods.

RCR is especially difficult to manage because it can persist in soil for at least seven years, making fields vulnerable to recurring outbreaks. This long-term survival limits management options and necessitates sustained disease control efforts. While seed-applied fungicides are commonly used, their efficacy against RCR is limited. Recognizing this gap, researchers and stakeholders have increasingly explored alternative strategies. One promising method is in-furrow fungicide application, where product is sprayed directly into the seed furrow at planting. This approach has shown success in Japan and remains the only effective strategy reported in southern U.S. states. As a result, attention is shifting toward integrated strategies that combine seed treatments with in-furrow applications—an approach that has yielded promising results in field trials. However, as RCR continues to spread, growers are applying greater volumes of fungicides in an effort to protect their crops, raising both environmental concerns and production costs. This escalating reliance on chemical control underscores the urgent need for innovative, integrated disease management approaches that help farmers use fungicides more efficiently and sustainably.

Targeted Fungicide Applications Begin with Early, AI-Driven Detection

Early detection of plant diseases is critical for effective control and for enabling sustainable, environmentally responsible, and economically viable management practices. Timely, targeted fungicide applications help prevent disease spread and reduce unnecessary chemical use. However, traditional scouting methods are not well suited for RCR. Leaf symptoms tend to emerge late—often after canopy closure—and the disease occurs in irregular, patchy patterns that make it difficult to detect. In-field scouting is labor-intensive, and definitive diagnosis often requires molecular assays that are time-consuming and impractical at scale. These limitations point to the urgent need for more efficient and scalable detection technologies.

At the regional and national levels, we have limited information about the spread of RCR across state lines. Current disease distribution maps are based on isolated diagnostic samples submitted to plant clinics, resulting in an incomplete picture of where and how rapidly RCR is expanding. This knowledge gap limits our ability to forecast outbreaks, deploy timely interventions, and coordinate a broader response.

To address these challenges, AI-driven tools—particularly those that combine remote sensing with machine learning—offer transformative potential. RCR produces characteristic symptoms such as leaf chlorosis, premature senescence, and irregular plant death, which can be detected from above using remote sensing technologies. Machine learning algorithms can be trained to process high-resolution spectral data and distinguish these patterns across landscapes. Similar AI-based approaches have already shown promise in monitoring other diseases in field crops. Building on that foundation, our AI-enabled systems allow for early, large-scale detection of RCR, delivering critical insights into disease dynamics and informing precise, data-guided fungicide use.

Using Satellite Imagery and Machine Learning to Guide Targeted Fungicide Applications

At UIUC, we are advancing the use of AI and remote sensing to detect RCR in soybean fields and guide precision fungicide applications. Our team explored spectral data from the blue, green, red, near-infrared, and red-edge bands, as well as key vegetation indices such as NDVI, GNDVI, and NDRE to develop machine learning models that can distinguish between healthy and infected areas using remotely sensed data collected during the growing season.

By training these models with ground-truthed data from fields with confirmed RCR outbreaks, we have demonstrated that these models can successfully detect diseased areas once symptoms appear. This approach enables large-scale disease surveillance and provides a foundation for site-specific fungicide recommendations.

We also applied our models to study disease progression over time. Using satellite imagery from multiple time points, the models can detect expansion in the diseased area within studied fields.

These insights underscore the potential of combining satellite imagery with AI, not only for early disease detection and understanding the spatial dynamics of disease spread, but also for guiding targeted fungicide applications. This work lays the foundation for scalable, data-driven strategies that support more efficient and sustainable disease management across soybean production systems.

From Detection to Action: Implementing Site-Specific Fungicide Use on Farms

Site-specific fungicide application is an emerging strategy that allows farmers to target disease hotspots instead of treating entire fields, improving the efficiency of disease control and minimizing environmental and economic costs. Advances in AI and remote sensing now make it possible to detect subtle patterns of crop stress at scale, offering timely insights that guide precise, on-farm fungicide use. By linking detection technologies with action-oriented tools, this approach shifts disease management from blanket applications to tailored interventions based on actual field conditions.

Our current research focuses on applying this approach to RCR in soybean. The long-term goal is to provide farmers with a remote sensing tool that detects RCR hotspots using high-resolution satellite imagery. This tool will generate prescription maps that can be integrated into tractor guidance systems, enabling precise, site-specific fungicide applications. For example, if the model identifies that only 25% of a field is affected by RCR, the prescription map will direct fungicide application only to those areas—reducing fungicide use by up to 75%. By minimizing unnecessary treatments, this approach supports more sustainable, cost-effective disease management at the field scale.

To achieve this, we continuously monitor fields with known RCR history using satellite imagery. Ground-truthed data are collected and combined with spectral information to refine machine learning models capable of detecting infected areas, even under varied field conditions.

To evaluate the real-world impact of this approach, we are preparing to launch on-farm trials comparing traditional uniform fungicide applications to those guided by our detection models. These trials assess differences in disease severity, yield, and pesticide use to determine whether targeted applications can achieve effective control with fewer inputs.

In addition, historical satellite imagery is being analyzed to understand how the disease spreads over time. By identifying spatial and temporal patterns, we aim to refine predictive models that help farmers anticipate outbreaks and take preventive actions earlier in the season.

The integration of AI with satellite imagery offers a powerful platform for proactive, data-driven disease management. For RCR and other pathogens, this approach enables informed, site-specific decision-making—supporting resilient, efficient, and sustainable soybean production at scale.

Broader Impacts: Reducing Chemical Use and Enhancing Disease Control at Scale

By integrating AI into crop protection, this work advances precision disease management in U.S. agriculture—reducing environmental impacts, lowering input costs, and increasing farm resilience. While the current focus is on RCR in soybean, the underlying technology is broadly applicable across crops and production systems.

Real-time remote sensing models can be adapted to track fast-moving, airborne pathogens such as rusts in corn and wheat, enabling early detection and timely, targeted fungicide applications before symptoms are visible. In perennial systems, remote sensing can identify diseased trees in crops like almonds and pistachios, allowing early removal or site-specific treatment to limit inoculum buildup. In vegetable production, such as tomato systems, early warning models can support spatially optimized fungicide strategies. The same AI-driven tools can also be applied to detect weed infestations, enabling precision herbicide applications, and reducing chemical use.

The environmental benefits are substantial. Conventional fungicide programs often result in overapplication, runoff, and negative effects on soil health and aquatic ecosystems. A precision approach supports selective, need-based interventions—reducing chemical loads, protecting biodiversity, and promoting long-term sustainability.

This research also cultivates a new generation of agricultural scientists trained in digital agriculture. Graduate students and postdoctoral researchers gain interdisciplinary experience at the intersection of plant pathology, agronomy, and machine learning, equipping them to drive future innovations in sustainable crop production.

Institutional Support: The Center for Digital Agriculture

This research would not be possible without the infrastructure, expertise, and collaborative environment fostered by CDA at UIUC. As a multidisciplinary hub, CDA brings together leading scientists and engineers from agriculture, computer science, engineering, and data science to solve pressing challenges in food and agricultural systems. The center provides critical resources—from high-performance computing to advanced sensing technologies—and facilitates partnerships across academia, government, and industry. CDA's mission to accelerate innovation at the intersection of agriculture and digital technology directly supports the development and application of AI-driven disease detection tools like those presented in this testimony. Through its support for translational research, education, and stakeholder engagement, CDA plays a vital role in advancing sustainable and resilient agricultural practices in Illinois and beyond.

Land-Grant Research: A Strategic Advantage for U.S. Agriculture

Public research at land-grant institutions like UIUC ensures that agricultural innovation is guided by transparency, scientific integrity, and public good. Tools such as the AI-driven technologies described in this testimony are developed with the goal of reducing production costs, improving input efficiency, and minimizing environmental impacts—often without the need for new or additional inputs. This unbiased, non-commercial research model is a core strength of the land-grant system.

At UIUC, this work has been supported in part by Hatch funding, which provides essential resources for foundational research aligned with the needs of farmers and the public. These investments ensure that early-stage innovation remains focused on broad agricultural impact—supporting producers, protecting natural resources, and delivering long-term value to taxpayers.